

INDIAN FORESTRY.¹

BEFORE retiring from the Indian Forest Service the author obtained the sanction of Government to the publication of this volume, which contains a brief description of the forests and a sketch of the introduction and growth of forestry in the British Indian Empire. In the preface he says: "My career in the Indian Forest Service has extended over thirty-three years, and though I was not in the country when regular forest conservancy was first introduced, I arrived when it was still quite a small sapling, and I have seen it grow to the mighty tree it is at present, under the wide-spreading shadow of which I have grown old."

Mr. Ribbentrop is one of the two young German forest officers whom the writer of these lines in 1866 was permitted to engage for the Indian Forest Service. He came from Hanover, where he had received his professional training, and had worked under the late Forst-director Burckhardt, one of the most eminent foresters of his day in Germany. The other was Dr. W. Schlich, now principal professor of forestry at Coopers Hill, whose excellent "Manual of Forestry" has repeatedly been discussed in these columns.²

Obviously it is out of the question, within the space here available, to follow the author through his description of the forests and through his account of the earlier stages of forest administration in India; it must suffice, briefly, to state a few of the principal results accomplished and to indicate the lines on which, in the interest of the 294 millions inhabiting the large British Indian Empire, further progress in this business ought to be made. As it will be satisfactory to deal with the last figures available, those for 1898-99 will, in a few cases, be quoted, the book giving only those to the end of 1897-98.

In 1899 the area of reserved Government forests in the different British provinces of India aggregated 84,148 square miles, or 54,000,000 acres, more than the total area of England and Ireland together. The State forests of the German Empire only aggregate 16,400 square miles. These are very large figures, but the British Indian Empire is a very large country. Of the total area of the German Empire the State forests occupy 8 and in the British provinces of India the Government reserved forests occupy 8.6 per cent. of the total area. At first sight this seems a most satisfactory result; the Indian State forests constitute a slightly higher percentage than those of the German Empire, a country where the necessity of good forest management is acknowledged to the fullest extent. Besides the 16,400 square miles of State forests, however, there are large areas of Crown forests, of forests belonging to public corporations, there are, further, 8400 square miles of communal and 26,000 square miles of private forests. All these, excepting a small proportion of the private forests, are managed as efficiently as the State forests. The Governments in the different States have shown the way, they have taken the lead in the management of their forest domains, and the other proprietors have gradually followed suit. The total forest area of the German Empire amounts to 54,000 square miles, or 26 per cent. of the entire area. Sixty years ago Germany was an important timber exporting country, since then, as a necessary consequence of the development of industries and manufactures, and the increase of wealth, the imports have gradually exceeded the exports. Now it is only second to Great Britain in the list of timber importing countries, and this is so, although the annual production of wood per annum is increasing steadily, as the result of the great progress made in forest management. The total annual production of timber and firewood of the German forests is estimated at 38,000,000 tons, and this is supplemented by an import of 4,600,000 tons. The material progress of the country would not be possible had it not the large home production to fall back upon. There are other forest lands in India which are nominally under the control of the Forest Department, viz. 8800 square miles of protected and 27,700 square miles of unclassified forests, but in these areas protection is nominal, and they are not managed with a view to a sustained yield. The reserved forests are the only trustworthy resource for the future, and these, as stated, only form 8.6 per cent. of the total area. One of the excellent maps appended to the book illustrates the distribution of these forests in the different parts of the Empire, and this

map shows at a glance the very unequal distribution. Berar has 23, the Central Provinces have 22, Burma has 9, but the North-West Provinces and Oudh have only 3.6 and the Punjab only 2 per cent. of Government reserved forests.

Nevertheless, it is an important point gained that so large an area is at the disposal of Government and that it is managed, so far as circumstances permit, with the view of obtaining from it a sustained and, if possible, steadily increasing yield of timber and other forest produce. The reader will ask the question whether it is right to lock up so large an area and to prevent the extension of cultivation, the establishment of fields within that area, in a country the population of which is mainly agricultural and is increasing steadily, which, indeed, is increasing with alarming rapidity in some districts and provinces.

What, then, has been the object in constituting this large area of reserved forest, and what is the object in maintaining it under forest? The author holds that the old records of Indian history, down to the invasion of the Punjab by Alexander the Great, prove that in those days extensive forests existed, and that the wholesale destruction of these forests has had the most deteriorating effect on the climate. He does not go so far as to maintain that by afforestation of large tracts the climate might be improved to such an extent as to stop the recurrence of these terrible seasons of drought, which are one of the chief difficulties with which the Government of India has to deal. It is evident, however, that his thoughts run in this direction. Doubtless it is not safe to lay stress upon such arguments. We may readily assent to the words of the author: "In a warm climate the denudation of a country diminishes its moisture and consequently its fertility" without indulging in the hope that in seasons of drought the presence of forests will increase the rainfall.

The local influence, however, of well-stocked forests in India no intelligent person, who knows the country, will deny. Well-stocked forests afford shelter to fields, to man and beast against the scorching winds of the hot season, and the dew is heavier in their vicinity. Of much greater importance still is the effect of well-stocked forests in regulating the surface drainage, in maintaining an even water supply in springs and streams, in preventing the denudation of hillsides, the silting up of rivers, and the destruction of fields and gardens in the plains by the sand and silt washed down from the hills. The author quotes a description of the Ratnagiri district on the western coast of the Peninsula, south of Bombay:—"Under a rainfall between 100 and 150 inches a year, this district is almost bare to the crest of the ghats, the result of fires, grazing and shifting cultivation. The four principal streams, which, rising in the Ghat Mountains, run a short course to the sea, were all navigable formerly, and were important for the trade of the country. Small boats still run, but the streams are gradually silting up, because the hills at their headwaters have become denuded."

In the Hoshiarpur district of the Punjab the Siwalik range of hills stretches from the Bias to the Sutlej river in a south-easterly direction. These hills consist of a very soft friable sandstone, alternating with strata of loam and clay. Formerly these hills were fairly well wooded. In 1846 they became British territory; the consequence was a rapid increase of population, a great demand for wood and charcoal in the fertile plains below, and the influx of a floating population of graziers with large herds of cattle. The result was complete denudation of these hills; the loose soil, no longer protected by vegetation, was washed down, broad rivers of sand spread into the plains below, and the end has been that fields and gardens of 940 villages, once prosperous, are now covered with sand, which has laid waste upwards of 70,000 acres of fertile lands. This district, rich formerly, is now traversed by numerous broad parallel sandy belts, cut out of the fertile and crop-bearing area.

Efficient protection of the reserved forests was only commenced a comparatively short time ago, and yet the author is able to state numerous instances from different parts of the country, in which protection has completely changed the character of the torrents and streams taking their rise in the forests. After rain, the water no longer rushes down, carrying sand and silt with it; the channels have been confined into permanent beds; they have become narrower and deeper, and the old beds to the edge of the channel have become stocked with grass and thousands of seedlings. The regulation of the underground waterflow takes more time, but Mr. Ribbentrop is able to report a case where, near a protected reserve in Ajmere, water is now found at the depth of 15 feet, where formerly it was not

¹ "Forestry in British India." By Berthold Ribbentrop, C.I.E., late Inspector-General of Forests to the Government of India. Pp. ii + 245, with 4 maps. (Calcutta: Office of the Superintendent of Government Printing, India, 1900). Price 4s. 6d.

² NATURE, vol. xlii. p. 121; vol. xlii. p. 265; vol. liii. pp. 510, 535.

reached under 25 feet. The denser vegetation, which is the result of efficient protection, has everywhere counteracted erosion, has prevented landslips and sudden floods.

These indirect advantages of forest conservancy are obvious and of very great importance, but in most cases the chief object aimed at has been the production of timber, bamboos, firewood and other forest produce. The produce yielded by the forests furnishes the revenue, which enables Government to maintain a proper management of these estates. In old times the requirements in wood and timber of the people and of Government were met without difficulty. But with the increase of population, the growing wealth of the people, the construction of railways and other public works, the demands upon the forests increased. Within reach of the railways and elsewhere, forests disappeared with incredible rapidity. The threatening scarcity of timber and wood compelled the Government to take action. The author gives an interesting account of the efforts made in the beginning of last century on the western coast to provide a permanent supply of teak timber for ship-building, efforts which failed completely, because most injudicious and unjust attempts were made to interfere with private property. In the same way the history of the Tenasserim forests is told, the conservancy of which was urged by Dr. Wallich in 1827, and which were gradually, but effectively, destroyed through a series of mistaken measures. In the adjoining province of Pegu, at the command of Lord Dalhousie, and under the guidance of Sir Arthur, then Major, Phayre, in 1856, a systematic management of the teak forests was introduced, ensuring the certainty of a permanently sustained yield of teak timber, while the friendly co-operation in the business of the Karen and Burmese inhabitants of the forests was secured, by giving them profitable and permanent employment in forest work. When, after five years of hard work, a steadily increasing surplus revenue from the forests had been realised, proving beyond question the great value of those domains, the timber merchants of Rangoon, naturally anxious to get this valuable property into their hands, had prevailed upon the Government of India to grant their request, and accordingly in February 1861, orders were issued to the Commissioner of Pegu to throw open the forests to private enterprise. These orders, which were praised as most enlightened and liberal by Anglo-Indian public opinion, seemed at the time to put a stop to all progress in this direction. Fortunately, at a later date, the greed of the permit-holders under the new arrangements, resulted in breaches on a large scale of the terms of their permits, the consequence of which was, that the permits were cancelled.

Not more steady was the progress made in other provinces in attempting to place the management of the forests in such a position as to enable them to furnish the needful sustained yield of wood and timber. When Sir John (afterwards Lord) Lawrence landed at Calcutta in January, 1864, as Governor-General, he had determined to stamp out this new-fangled scheme of forest administration, which would weaken the position of the chief civil district officer by taking away from him the charge of the forests. It was only through the fortunate accident that Sir Richard Strachey, at the time secretary to the Government of India in the Public Works Department, who had some time previous taken charge of the forest business, gradually gained influence over the Governor-General to such an extent, that actually in Sir John Lawrence's reign the forest establishments under the Government of India were placed on a regular organisation.

Apart from reckless cutting, the improvement of the forests was impeded by two old-established practices, grazing and the jungle fires of the hot season. Two important and interesting chapters are devoted to these subjects, to the efforts made to regulate grazing and to protect the forests against fire. Here it must suffice to state that systematic fire protection was commenced in the Central Provinces in the hot season of 1865. Colonel Pearson, then Conservator of Forests in that province, had serious doubts on the subject; he knew that any attempt to interfere with this ancient institution, which cleared the ground of inconvenient grass and underwood, would be distasteful to all Europeans as well as natives. With the powerful support of Sir Richard Temple, then Chief Commissioner of the Central Provinces, he made the attempt. He selected the Bori forest in the Satpura range, a district most favourably situated for the experiment. He succeeded, and within a few years he saw the condition of the forest entirely altered. The extensive grasslands and smaller blanks in the forest gradually

filled up from the edge with coppice shoots and self-sown seedlings, the soil, which hitherto had been hardened and sterilised by the annual fires became fertile, the trees increased rapidly in height and girth, and the fresh shoots of the bamboo became taller and stouter. Gradually this difficult work was taken in hand in all provinces, and in 1899 no less than 29,492 square miles were successfully protected against fire, or one-third of the total area of reserved forests. The expense of these operations latterly has been between ten and eleven rupees per square mile.

The question will now properly be asked: Who pays for all this business? Forest revenue and expenditure have increased steadily ever since forest business was properly organised. In 1898-99 the results were as follows:

Revenue	...	Rs. 1,90,38,520, or 1,270,000/.
Expenditure	...	„ 1,00,33,920, „ 670,000/.
Surplus	...	„ 90,04,600, „ 600,000/.

This, it is true, is only a small contribution to the annual revenues of the British Indian Empire, which in the same year amounted to 1,01,40,00,000 rupees. But it is something, and the surplus is increasing steadily. Certainly it must increase, for at present it only amounts to 2·7*d.* an acre. In some provinces, fortunately, the surplus is higher. Since the annexation of the kingdom of Burma the reserved forests in this province are:

7,679 square miles in Lower Burma.
7,988 „ „ in Upper Burma.

Total 15,667 square miles.

Both in Upper as well as Lower Burma teak timber is the principal and most valuable produce of the forests. The teak forests of Upper Burma had been leased by the King to powerful firms at Rangoon under the vaguest conditions. The lessees were only liable to the payment of a lump sum per annum, without reference to the amount cut by them. Under these conditions the utter devastation of the forests within a short time was inevitable. It has been Mr. Ribbentrop's privilege, after the conquest of the country in 1886, to induce the Government to claim the right of interference, and it is entirely due to the tact and determination with which he conducted the negotiations that a settlement was arrived at, under which no trees can be cut that have not been selected and girdled by the Forest Department. Thus this valuable property was saved from ruin, and it is satisfactory that the last of the leases will shortly expire. The surplus realised by the Burma Forests in 1899 was 59,24,000 rupees, corresponding to 1·3*d.* an acre. This is better than the amount realised from the whole reserved forests of the British Indian Empire. But even this is a poor result as compared with the yield of properly managed forests in Europe. Of all States of the German Empire, Prussia has, owing to unfavourable soil and climate, the least productive forests, and the average net yield of the State forests is only five shillings an acre, while the State forests of Saxony yield twenty and many forest ranges in that country yield thirty to forty shillings an acre. Much progress, therefore, has still to be made in improving the condition and productiveness of the Indian forests before they can hold their own in comparison with the forests of Europe. This result, however, will be attained provided a sound and vigorous forest policy is continued.

Besides timber, wood and bamboos there are numerous other substances, such as tanning materials, gums and caoutchouc, necessary for the every-day life of the people and required for the commerce of the world, which are produced and will be produced on a much larger scale, provided the forests are efficiently protected and properly managed. From all this a growing surplus revenue may be obtained. There is, however, a class of forest produce more important than all these for the welfare of the country, which cannot be expected to contribute very largely to the surplus forest revenue. This is grass and cattle fodder.

In a hot climate, except in districts with an exceedingly heavy rainfall, a better crop of grass is produced under the shade of trees than in the open, and this is particularly the case in seasons of drought, to which, unfortunately, large portions of India frequently are subject. In the dry climate of Rajputana numerous chiefs and princes had from time immemorial established game-preserves, chiefly as cover for pigs. The forest growth in these preserves was carefully protected, and during the terrible famine

which devastated that country in 1867, 1868 and 1869, they furnished an abundance of grass and branches of trees to feed the cattle of the neighbouring towns and villages. Two small British districts, Ajmere and Merwara, are situated in the midst of these native States of Rajputana. Here the whole of the waste and forest lands at the disposal of Government had, at the settlement of 1850, been handed over to the villagers, the State relinquishing its rights in these lands. The results of this "liberal" policy had been disastrous. The hills had become denuded, the timber was sold, the wood was used and these lands had become utterly barren and unproductive. For their crops the people of these districts almost entirely depend upon irrigation. The water is furnished by numerous ponds or tanks, formed by embankments thrown across valleys at convenient points. Many of these tanks are old, others have been built since the country came under British rule. The scanty rainfall in these districts does not come down continuously, but in a small number of heavy showers. The rain rushed down the denuded hillsides in torrents and, instead of filling the tanks slowly but steadily, burst the embankments or filled the tanks with the silt which the floods had brought down. These districts the writer visited in December 1869. The cattle had perished, the people had fled, large villages were entirely deserted, and the country was almost depopulated by these years of drought and famine. Adjoining the district of Merwara on the east side is the territory of the Thakur of Bednor, a feudatory to the Maharajah of Udaipur, and the contrast was extremely surprising—in British territory the hills denuded, in Bednor the hills wooded, the forest having been carefully protected. From the top of Bairat Hill, on January 2, 1870, we looked down upon the town, with its large tank and beautiful groves of fruit trees, and here the Thakur's eldest son, who had the management of the forest lands, told the writer how the Nasirabad charcoal contractors had come, offering large sums if he would allow them to cut. He had refused and would always refuse their request, knowing well that the grass in the forest and the branches of the trees had saved the cattle of Bednor in seasons of drought, and that the water supply in the tanks, upon which the fertility of the country depended, was maintained by the forest growth on the hills.

After several years' hesitation, action was at last taken, in 1874, to remedy the mistakes which, with the best intentions, had been made in 1850. The Ajmere Forest regulation was passed, which gave the Chief Commissioner of those districts power to take up any tract of waste or hilly land as a State forest, granting the people who had formerly had an interest in that land the right of cutting grass and wood in it for their own requirements and a liberal share in the net proceeds from the management of these lands. This measure, at first sight, might be termed a confiscation of rights deliberately granted. In reality, however, the proprietary rights had at the settlement not been granted to individuals, but to the village communities. They were communal lands, and as such public, not private, property. Government, therefore, as the guardian of all public interests, had the duty to interfere. This small measure, had it been properly followed up, might have been one of the most beneficial measures passed in the reign of Lord Northbrook. Unfortunately, only 139 square miles, or 5 per cent. of the total area, have been demarcated as State forest in Ajmere-Merwara. And worse than this, grazing was frequently allowed without real necessity, and consequently protection remained incomplete. Nevertheless, with all these drawbacks these reserves are now very fairly stocked with trees and shrubs, and they have proved a great protection to these districts in times of drought during the last twenty years.

In the famine, which affected a large portion of the Bombay Presidency in consequence of the short monsoon of 1896, operations were undertaken on a large scale to provide cattle fodder from the forests to all districts which needed such help. Mr. Allan Shuttleworth, the Conservator of Forests, organised and directed these operations. Presses were set up near the forests, roads were constructed, hay was made and pressed in 80 lb. bales, which were despatched by train, and were sold at cost price at depots all over the affected districts. The same plan was pursued in the late famine, and has also been adopted in other provinces. Grain can easily be sent to districts affected by scarcity, the provision of cattle fodder is more difficult, and in previous famines the loss of cattle has always been the chief calamity. When at last rain falls and no cattle are left to plough, the distress is terrible. Millions of cattle have been

saved by these measures, and it is to be hoped that the ruling authorities in India will always bear in mind that if in seasons of drought the forests are to be in a position to furnish cattle fodder on a large scale, they must in ordinary years be efficiently protected against fire and must not be indiscriminately opened to cattle.

Besides the areas which are classed as forests, there is in each province a large extent of waste, aggregating upwards of 380,000 square miles, or considerably more than one-third of the entire area of the British provinces. At present these waste lands furnish wretched pasture, the scrub and isolated trees upon them yield fuel, and, on a small scale, wood for building and agricultural implements. One of the most important, but at the same time most difficult, tasks awaiting Indian foresters in the future is to undertake the management of these lands. On a small scale something in this direction has been done by the formation of canal plantations, and the establishment of fuel and fodder reserves in a few districts. But the work must be taken in hand on a much larger scale and on a methodical system in all provinces. Under good management these lands will produce heavier crops of firewood and cattle-fodder. At present manure is used as fuel in most districts, and the result is, in spite of the skill and industry with which the Indian peasant cultivates his land, an exceedingly poor yield of crops. In his report on the improvement of Indian agriculture, Dr. Voelcker justly urges the establishment on a large scale of fuel and fodder reserves, in order to supply wood to take the place of cow-dung as fuel. "If wood," he says, "could be made to take the place of dung for fuel, we should soon come to realise that more wood means more manure, that more manure means heavier crops and an increasing fertility of the soil."

It is not impossible that these measures may eventually lead to the formation of village forests. Experience has shown in Germany, in France and in other countries of Europe, that municipal self-government of towns and villages develops in a healthy manner where these municipalities have landed property, provided it is well and efficiently managed. The communal forests in these countries contribute largely to the prosperity of the agricultural population. They furnish all the wood and timber the villages require, and the sale of the surplus yields a steady annual income, in many cases sufficient to cover the charges of the municipality for roads, schools, churches and other purposes.

In a number of interesting chapters the author explains the nature and extent of the rights which Government possessed in the waste and forest land of the different provinces at the time that the State forest reserves commenced to be established. The British Government had legally succeeded to the rights actually exercised by the former rulers of conquered or ceded States at the time of conquest or cession. Consequently, the unoccupied waste, including forests, as a rule, was the property of the State. In these waste and forest lands, however, the people had grazed their cattle, had cut wood and bamboos for their use, and had cleared land for shifting or permanent cultivation. Under the former native Governments the forests had thus been used by the people, not as of right, but subject to the good pleasure of the ruler. When the preparation of proper forest laws for the different provinces was considered, between 1869 and 1878, the most important question was, to what extent this long-continued user of the Government forests should be regarded as constituting a prescriptive right; and it was deliberately settled that the customary user of the forests under British rule must be held to constitute a prescriptive right. On the other hand, it was acknowledged that Government, as the guardian of all public interests, must insist upon the regulation of these rights, so as to render possible a good management of the reserved forests in the interests of the country.

It was held that the growth of forest rights in India had been analogous to the growth of similar rights of user in Europe, and consequently that the legal provisions for regulating them or, in case of need, for extinguishing them by means of suitable compensation, must be analogous to forest laws made in Europe.

By the Indian Forest Acts the duty of deciding which claims shall be admitted as a right, as well as the regulation and commutation of rights thus admitted, is entrusted to special officers, styled forest settlement officers, and an appeal from their decisions is provided. Under the procedure prescribed by these acts, the 84,148 square miles of reserved forests have been settled. In many cases was it possible to extinguish the rights by suitable compensation; in others the forest remained burdened with rights to pasture or the cutting of wood, but these

rights were strictly defined in regard to area, the number and description of cattle admitted to graze, and the amount of timber to be cut. In many instances the settlement officers have gone far beyond the requirements of the law; they have often been disposed to place heavy burdens upon the Government forests, in order to make matters as comfortable as possible to the people in the vicinity. Especially in regard to pasture, the tendency of most Governments in India has been to insist on cattle being admitted to graze in the forests far in excess of what was prescribed by the forest settlement. Young forest growth cannot come up under heavy grazing. In seasons of drought, as a matter of course, the forests must be, and are, always thrown open. But if this is done in ordinary seasons, the forests cannot improve, and cannot provide what is wanted in times of scarcity.

In these circumstances agitation against forest administration is of frequent occurrence. In his delightful and most important work, "Forty-one Years in India," vol. i. pp. 441, 442, Lord Roberts states: "Amongst the causes which have produced discontent of late years I would mention our forest laws and sanitary regulations, our legislative and fiscal systems—measures so necessary that no one interested in the prosperity of India could cavil at their introduction, but which are so absolutely foreign to native ideas that it is essential they should be applied with the utmost gentleness and circumspection. . . . The proceedings and regulations of the Forest Department, desirable as they may be from a financial and agricultural point of view, have provoked very great irritation in many parts of India. People who have been accustomed from time immemorial to pick up sticks and graze their cattle on forest lands cannot understand why they should now be forbidden to do so, nor can they realise the necessity for preserving the trees from the chance of being destroyed by fire, a risk to which they were frequently exposed from the native custom of making use of their shelter while cooking, and of burning the undergrowth to enrich the grazing."

In these words Field-Marshal Lord Roberts faithfully expresses the views of many leading public men in India. And yet the development of the British Indian Empire, through railways and telegraphs, through extended irrigation, the steadily growing wealth of its inhabitants, necessitates the maintenance and improvement of its forests, while the persistent growth of the population, in spite of famines, cholera and plague, demands that the large areas of waste lands should produce more cattle-fodder and more firewood. These are demands which cannot be resisted.

A detailed account is given of the Dehra Dun Forest School, which was established in 1878 for the professional training of native forest officers. Of the first director of that institution, Captain (now Colonel) F. Bailey, R.E., the author justly states that it was entirely owing to his exceptional powers of organisation, energy and ability that the new institution took healthy root from the outset. It has been explained at the outset of this article that in 1866 two young forest officers from Germany, Dr. Schlich and Mr. Ribbentrop, were engaged for the Indian forest service. In the same year arrangements were made for the professional training of young Englishmen in the State forests of France and Germany. The first selection was made in 1867, and the first men trained under this system joined their province in 1869. Since then a varying number has been sent out annually. In 1887, after the arrangements in France and Germany had come to an end, the first men arrived, who had been trained under existing arrangements at Coopers Hill. Altogether, until 1899, 207 professionally trained men have gone out, of whom in that year 152 were still in the Indian Forest Service. This number obviously is wholly insufficient to provide for the management of 84,000 square miles of reserved forests. Moreover, the small surplus revenue yielded by these forests would make it out of the question to employ English officers for their management. In the State forests of the kingdom of Saxony, the mean area of a forest range or executive charge is 4000 acres. The executive officer, here styled *Oberförster*, receives the same professional training, and has the same social standing, as the higher forest officers to whom he is subordinate. Every member of the superior Forest Service begins his career as assistant to the *Oberförster*, and his first appointment to a responsible post is that of executive officer. This organisation ensures efficiency, because the *Oberförster* has a reasonable chance, by distinguished service, of rising to the highest appointments in the department.

An organisation as simple and effective as this is impossible in India. The revenue of the forests is too small. Further, the officers must necessarily belong to two classes, expensive Englishmen for the higher appointments, and natives at lower rates of pay for the executive charges, and these two classes cannot be amalgamated. Four thousand acres in Saxony yield a net revenue of 4,000*l.* at 20*s.* an acre; the area required to produce a similar revenue in India would be so large as to be quite unmanageable for one executive officer. Thirty square miles, or 19,200 acres, would be a large but still manageable area in India. From 1888 to 1899 the surplus has doubled, and it is not unreasonable to expect that in 1910 it will amount to 6*l.* an acre. At that rate 30 square miles would yield an annual surplus of 480*l.* By that time there ought, therefore, to be 2800 professionally trained forest officers for the executive charge of these forest ranges. The actual number of forest rangers in the different provinces at present (July 1, 1900) is 425. The organisation, therefore, of executive charges is far from complete. To a great extent the executive management of these estates is at present in the hands of the superior controlling and directing officers, who do the work through the agency of forest guards and other protective officers, men who have received no professional training.

The chief difficulty at present is, that the men who enter the Dehra Dun Forest School belong to a lower social stratum than is desirable. And this will continue until means are found to give forest rangers reasonable prospects of promotion. Something in this direction has been done by establishing a provincial branch of the superior Forest Service, so that from time to time a few really distinguished forest rangers may be promoted. And when the advantage of relying mainly upon native agency in forest business has been fully recognised, means doubtless will be found to improve the prospects of advancement for native forest rangers. No possible political difficulty can arise through employing natives of India in the higher branches of the forest service, and hence it seems right to use this department to make the experiment.

Sir Thomas Munro, one of the most distinguished Indian statesmen in the early part of last century, while Governor of the Madras Presidency, wrote as follows on December 31, 1824: "All offices that can be held by natives without danger to our power might with advantage be left to them," and further on follow remarks to the following effect: "To improve the character of the natives we must open the road to wealth and honour and public employment." Since 1824 the British Indian Empire has not only increased enormously in extent and population, but good government, the security of persons and property, the impartial administration of justice, the growth of commerce and manufactures, irrigation works, roads, telegraphs, railways, and by no means least, schools and colleges, all this has brought about a tide of progress which cannot now be stemmed. But the blessings of progress will be valued more by the people if they are not all dispensed by the hand of the foreigner, if natives themselves are the agents, to a greater extent than is the case at present, in the undertakings which contribute to their well-being.

Mr. Ribbentrop is not an advocate of these plans, yet on several occasions he bears testimony to the excellent work done by natives of India, provided they have received a good professional training in surveying or forestry. A weighty objection is raised by parents in this country that plans like these will take the bread out of their sons' mouths. Latterly from six to eight men, who had received their professional training at Coopers Hill have been sent out annually. It may be regarded as certain that, if all goes well, the number required will increase largely, not only because the management is gradually becoming more intensive, improving the yield capacity of the forests and augmenting the revenue, but also because a constantly increasing number of Indian forest officers are required in native States and other countries, such as Siam, and in the British Colonies. Even should a few more appointments be filled up by the promotion of native forest rangers, the number of men required from Coopers Hill will not diminish but will increase. And surely it is better that a policy should be followed which will tend to place British rule in India upon a safe foundation than that a few more appointments should be available for young men at home. The beneficial effects of forestry will not be fully realised until it ceases to be an exotic plant. The educated natives of India must feel that they are the allies of the British Government, and this can only be brought about by giving them

a larger share in all works undertaken to promote the welfare of their country.

The author does not claim to be a botanist, nor does Dr. Schlich, who preceded Mr. Ribbentrop, nor does their successor, Mr. H. C. Hill, the present Inspector-General of Forests. It is necessary to mention this because in England, also among scientific men, the opinion prevails that forestry is a branch of botany, and that a forester who is not a botanist cannot claim to be a scientific man. Dr. Schlich's great merit while holding the appointment in India was to organise that branch of forestry which deals with the plans regulating the working of the forests, a business which is based more upon mathematics than upon botany. Mr. Ribbentrop's great achievement has been to study and correctly to appreciate the peculiar sylvicultural requirements of the great variety of trees and bamboos with which the forester has to deal in India. Through his labours the management of teak, of sal, sissoo, deodar, and of other important trees when growing by themselves or in company with other kinds or with bamboos, their regeneration, natural or artificial, and their subsequent treatment under different conditions of soil and climate, is much better understood now than it was twenty years ago. These are great results, which, provided no retrograde measures are adopted, will bear fruit in steadily increasing the productive powers and capital value of the forests, and will contribute largely to the welfare of the millions inhabiting the British Indian Empire.

DIETRICH BRANDIS.

SUBMARINE BOATS.

THE building of five submarine boats for the British Navy not only forms quite a new departure but also, perhaps, the advent of the nucleus for an instrument of war of novel design. The boats (says *Engineering*, March 29), which are being built by Messrs. Vickers, Sons and Maxim, Ltd., are of the *Holland* improved type and are 63 ft. 4 in. in length over all, 11 ft. 9 in. beam, and 120 tons displacement submerged, and they will be capable of expelling torpedoes either with the boat at rest, during the run on the surface, or steaming at any speed submerged. When running on the surface the boats will be propelled by a gasoline engine (of marine type, inverted, and with four single acting cylinders). The amount of fuel carried will suffice for a run of about 400 miles with a maximum speed of about 9 knots, and when submerged an electric motor of the waterproof type, worked with storage batteries, will give the vessel a speed of seven knots, which can be maintained for four hours. The general operation of the boat is given as follows:—"Before it is desired to make a dive, the boat is brought to 'awash' condition, with only the conning tower ports above the water. The dive is then made at a small angle until the proper depth is reached, when by automatic means the boat is brought to a horizontal position. After the discharge of the torpedo from the fixed bow tube, the compensation for the weight of the torpedo is made automatically, causing only a slight change of trim for a few seconds. Provision is made for quick rising and diving, the time of appearance of the conning tower above the water being dependent on the skill of the navigator." In the United States Navy the *Holland* has undergone most exacting trials and has proved herself "stable in service working," and it is here we get the most convincing testimony, where Admiral Hittchorn, chief constructor in the United States Navy, states in his official report, "The *Holland* has shown herself capable of such complete control in the vertical plane that she may be kept within a few inches of any desired depth while moving, or brought to the surface and taken under again in a very short time; her direction and control in the horizontal plane on the surface is effected with the same facility as any other craft, and submerged is limited only by the difficulties of vision: her crew are provided for on board with reasonable comfort and perfect safety for such periods as she may be in service and working either upon the surface or submerged; and her armament, consisting entirely of torpedoes, gives her great offensive power."

THE CURRENTS IN THE GULF OF ST. LAWRENCE.

IN a former article (January 24, 1901, p. 311) we gave a summary, from a pamphlet recently issued, on the currents in the Gulf of St. Lawrence, in which we noticed some points of general application to similar researches elsewhere. This pamphlet, issued by the Department of Marine and Fisheries,

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Canada, gives concisely the results of investigations in the summer seasons of three years in that Gulf, conducted by Mr. W. Bell Dawson, in charge of the Survey of Tides and Currents. It is primarily for the benefit of practical seamen; but it also contains an explanation of the hydrography of the Gulf, on which this Survey has thrown considerable light; and it is this part that we now summarise.

General Characteristics of the Gulf of St. Lawrence.—With the exception of the currents in the various straits and near the heads of the bays, the currents met with in the open Gulf seldom exceed one knot. They are, therefore, the more easily influenced by strong winds, especially at the surface of the water. Currents which have a greater speed than this are found in Belle Isle and Cabot Straits, in Northumberland Strait, off the Gaspé coast, in the Gut of Canso, and locally in channels between islands and at the mouths of rivers.

The water of the Gulf may be roughly divided by a line running from South-west Point of Anticosti to the middle of Cabot Strait. Along the south-western side of this line the water has a lower density, as it is apparently made a little fresher by the outflow of the St. Lawrence River. To the north-east of this line, throughout the north-eastern arm of the Gulf, the water has the same density as in the open Atlantic.

The general drift of this water of lower density is outward, towards the Atlantic. This gives rise to two constant currents, one at the mouth of the St. Lawrence along the Gaspé coast, which may be called the "Gaspé Current," and the other on the west side of Cabot Strait around Cape North, which may be called the "Cape Breton Current." A third constant current is found on the west side of Newfoundland, making north-eastward from the Bay of Islands towards Rich Point.

It is to be noted that in calling these currents constant it is only meant that they usually or most frequently run in the one direction. During certain winds they may be much disturbed, or their direction may even be reversed.

Temperature.—It appears that in general the temperature of the surface water merely rises with the progress of the season; and it is also natural that the water should become warmer to a greater depth as the season advances. Even this has its limitations, however; as at a depth of 50 fathoms no greater rise in temperature has yet been found than from 32° to 34°, between the month of June and the end of September.

At all three angles of the Gulf it was found that the coldest water forms a layer between the depths of 30 and 50 fathoms. In the vicinity of Belle Isle Strait, the same low temperatures are also found at these depths; although there the temperature towards the surface is relatively lower, as a rule, than in other regions. It is probable that this cold layer extends very generally over the Gulf area. Below this cold layer, in the deep channel of the Gulf, the temperature from 100 to 200 fathoms is found to range very constantly from 38° to 41°. This result was obtained in Cabot Strait, and also between the Gaspé coast and Anticosti, 220 miles further in from the Atlantic, along the deep channel. This deep channel runs into the Gulf from the Atlantic basin through Cabot Strait, and maintains a continuous depth of some 200 fathoms across the middle of the Gulf to the mouth of the St. Lawrence River. It still has a depth of 100 fathoms half-way up the estuary on the Lower St. Lawrence.

Density.—It may be stated broadly that throughout the north-eastern portion of the Gulf the average surface density ranges from 1.0235 to nearly 1.0245; while in the south-western portion the density is below 1.0235, ranging usually down to 1.0220, and falling in the Gaspé Current itself to 1.0210. The dividing line between these two portions of the Gulf runs approximately from South-west Point, Anticosti, to a point in the middle of Cabot Strait. The densities in the border region near this dividing line naturally vary to some extent. The density of the north-eastern portion is practically the same as in the open Atlantic, as it was there found to range from 1.0237 to 1.0242, as shown by seven determinations made at the end of June off the south and south-east coasts of Nova Scotia.

This result is important in showing that the lower densities found in the south-western portion of the Gulf of St. Lawrence are confined to that side; and this also accords with the conclusion that the general set or drift across the Gulf is in the direction of a line from Gaspé to Cape Breton. On the other hand, the endeavour to obtain some differences locally, which would correspond with the various directions of the current, was without result; although a large number of temperatures as well as densities were taken for this purpose.

The deep water as found from samples taken at depths of 100